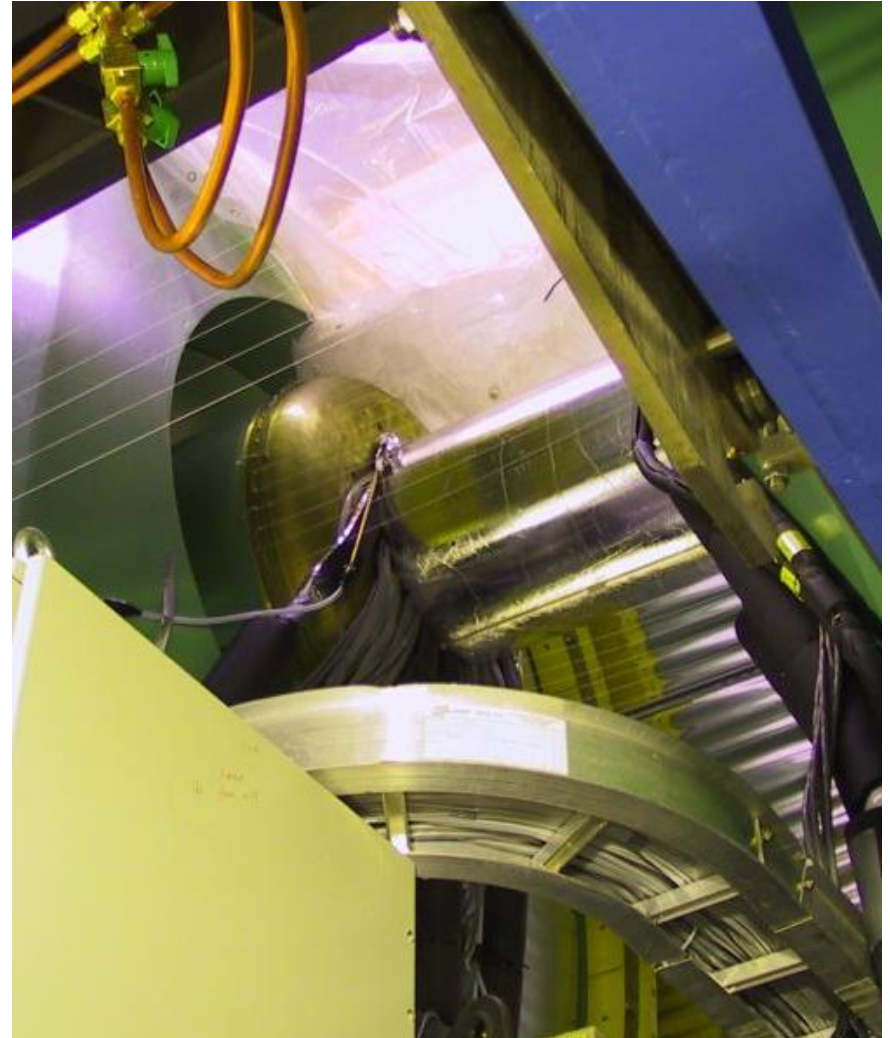# MVD
multiplicity and vertex detector

The MVD is (used to be) the only detector in Phenix that you can carry out of the IR alone without hurting your back.

a bit of prehistory

Phenix is amalgam of several competing experimental proposals. One was an electron-gamma detector, one was a hadronic-probes detector,and one was a muons-only detector.

The forced marriage in 1991 led to the current collaboration.

The e-gamma faction came out on top, followed by the hadronic probers, and the muon team.
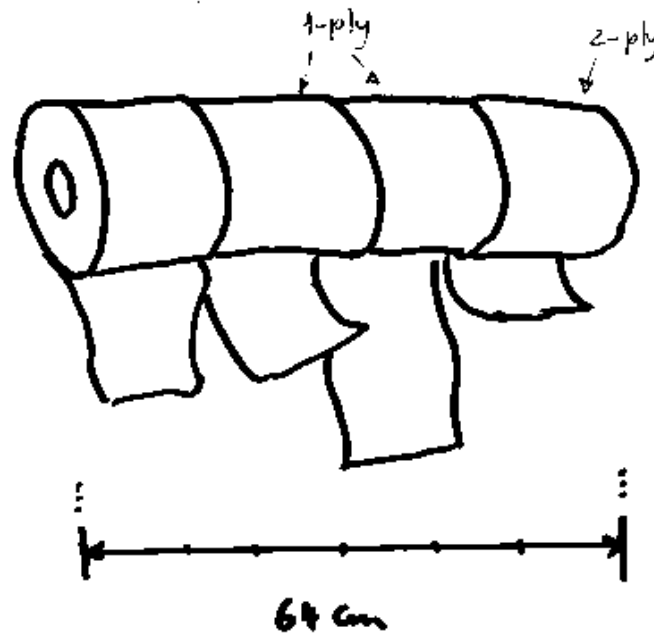
For the **MVD**, which came from the hadronic sector, this meant that **mass reduction** was paramount, in order to accommodate the electron arms.

... MEANWHILE, BACK AT FRANKENSTEINS CASTLE ....

DOE

BNL
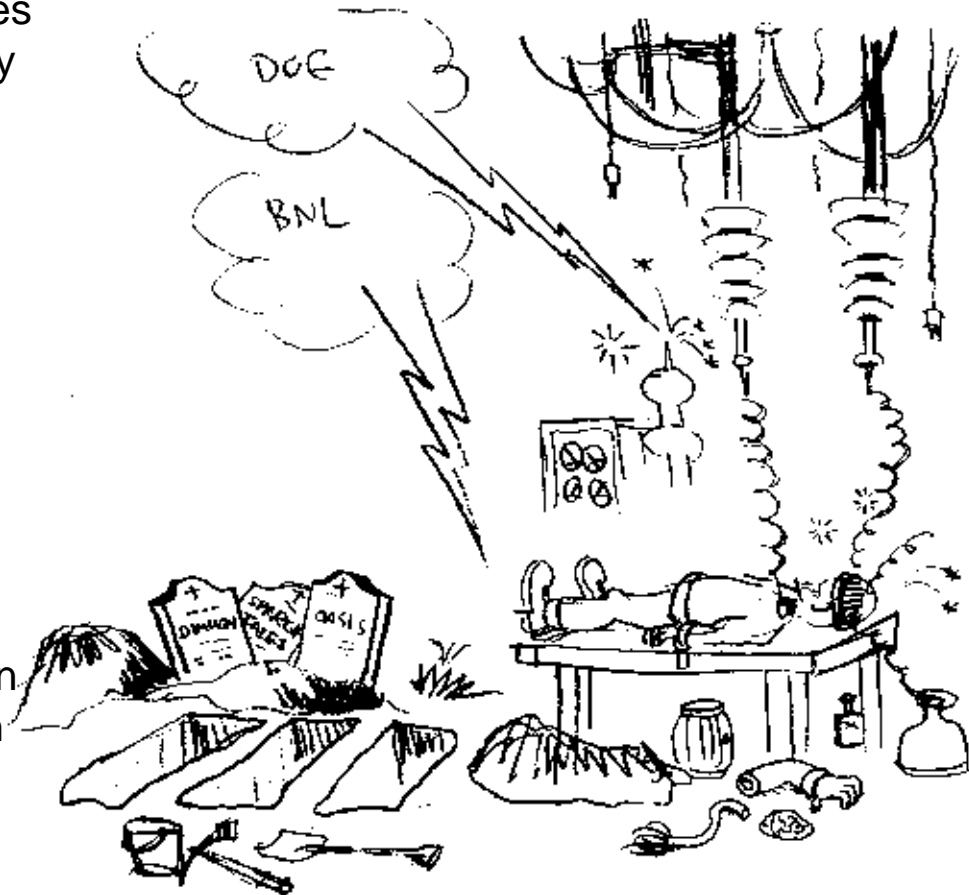
we're lightweight

we're lightweight

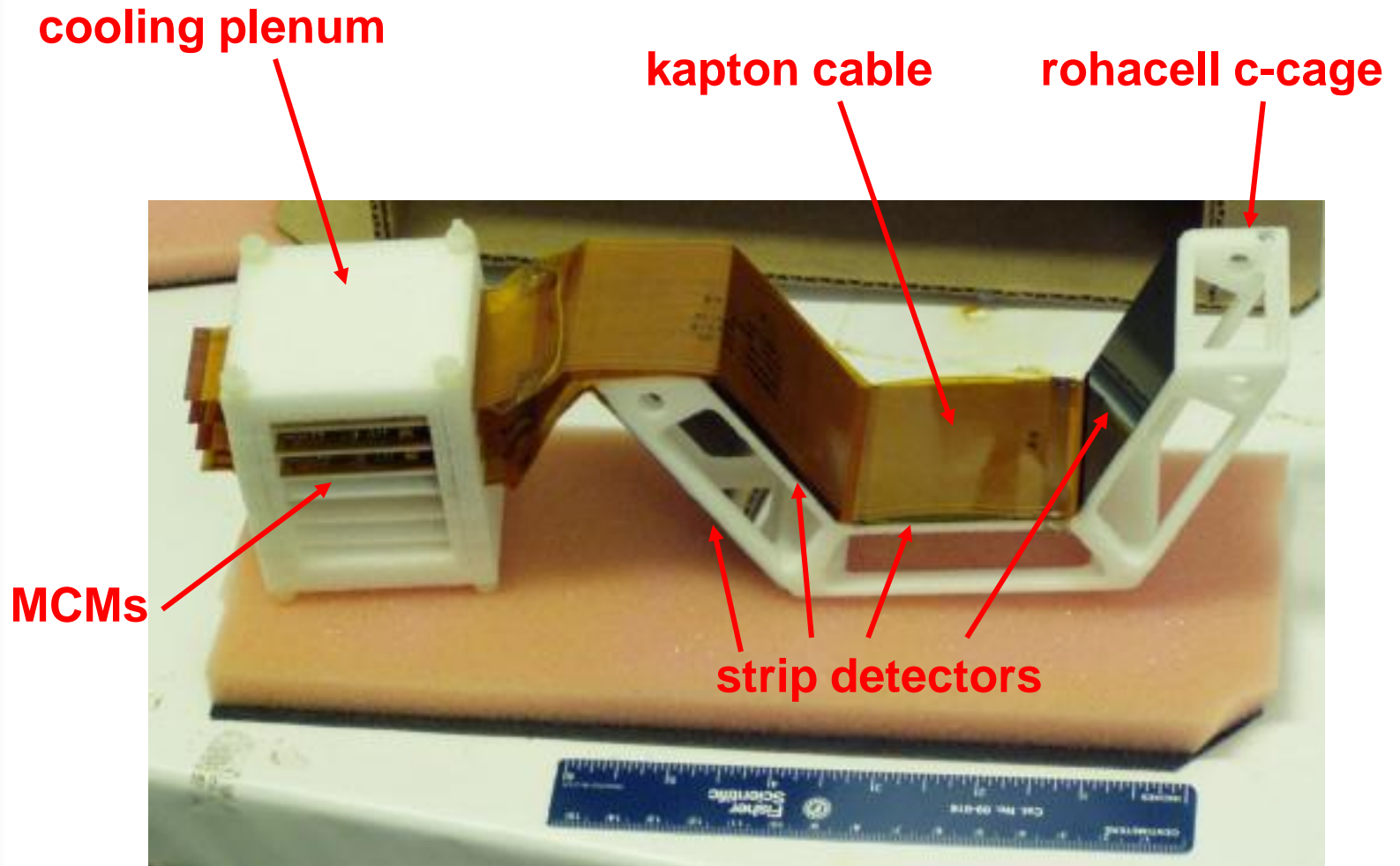| Description	Material	Radiation Length
Inner Enclosure Wall	0.01mm Al 2 mil adhesive 3mm Rohacell 2 mil adhesive 0.01mm Al	0.014 % 0.017 % 0.055 % 0.017 % 0.014 %
Inner Silicon Layer	0.3mm Si	0.321 %
Rohacell Cage (*)	24.4mm Rohacell x average mass ratio	0.109 %
Outer Silicon Layer	0.3mm Si	0.321 %
Kapton Cable	0.05mm Kapton 0.005mm Cu (x .5 area) 0.005mm Cu (x .1 area)	0.020 % 0.018 % 0.004 %
Outer Enclosure Wall	0.01mm Al 2 mil adhesive 6mm Rohacell 2 mil adhesive 0.01mm Al	0.014 % 0.017 % 0.110 % 0.017 % 0.014 %
	Grand totals for 1 layer of Silicon for 2 layers of Silicon	0.76 % 1.08 %

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1/2 MVD, without cover foils

Year-3 configuration - full barrel

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one C-cage assembly

cooling plenum

kapton cable

rohacell c-cage

MCMs

strip detectors

Phenix Focus March 2004

pad detectors

MCM

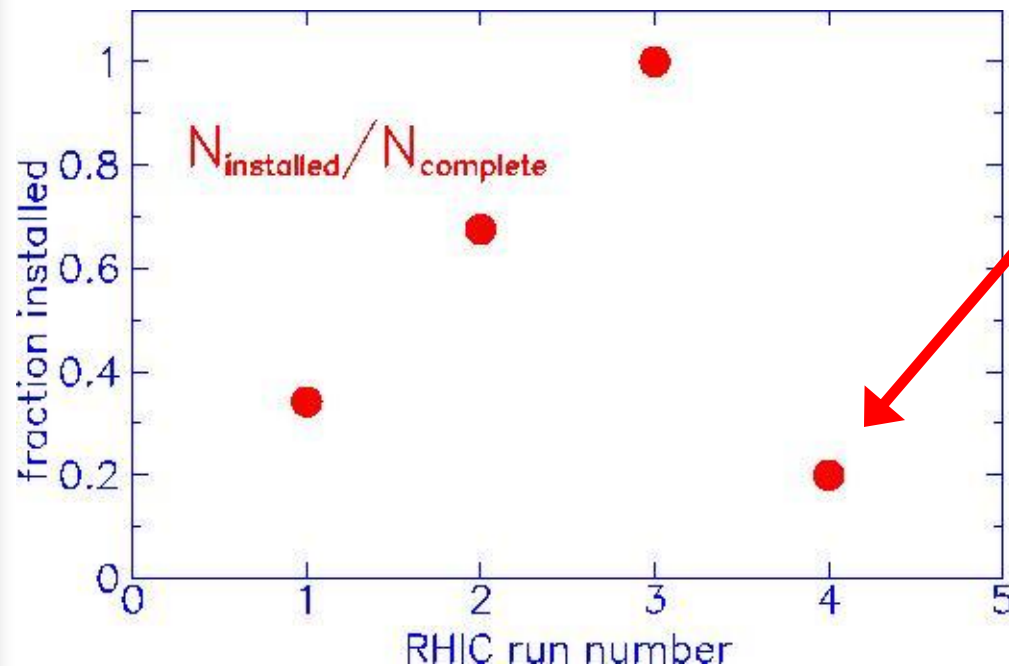pad detector

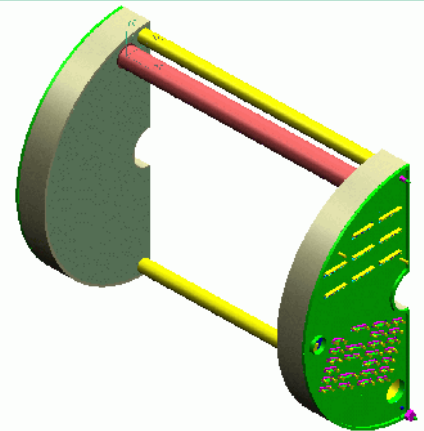output cable

1 pad det = 21x12 pads

MCM cooling cover

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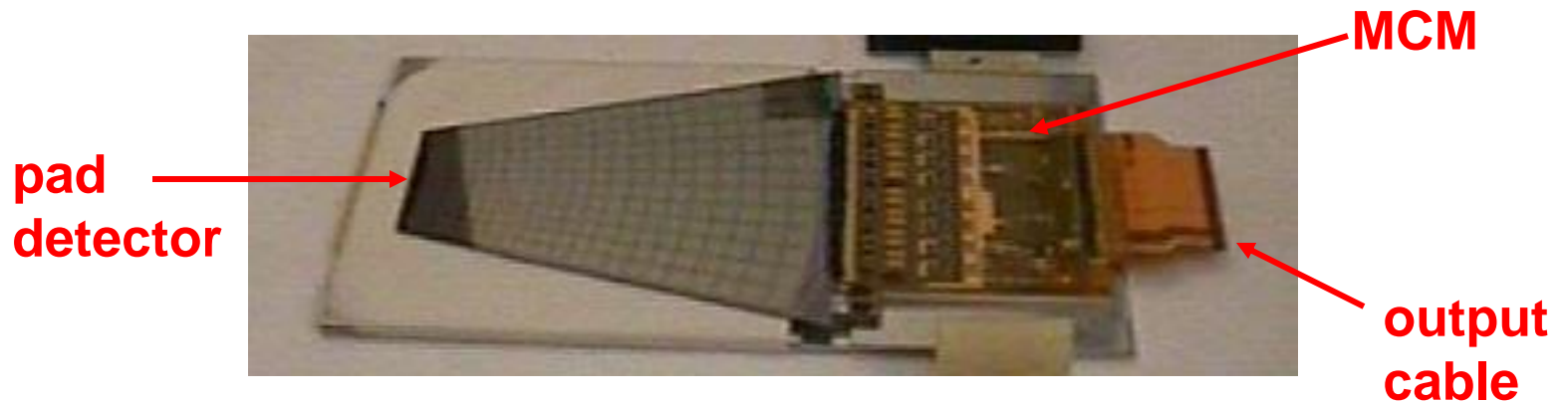
MVD history

Current situation: Only pad detectors are installed (20% of total channels)

With the current version of the MVD, we can make significant contributions to multiplicity, dN/deta, centrality, and reaction plane measurements. We can't find the vertex.

history of the MCMs

•Problems with Multi-chip module (MCM) yield & production schedule.
• Phenix year-1 ~30% instrumented
• Phenix year-2 ~60% instrumented
• Phenix year-3 completed

preamp discr.   **AMU ADC**   **FPGA**

256 chan
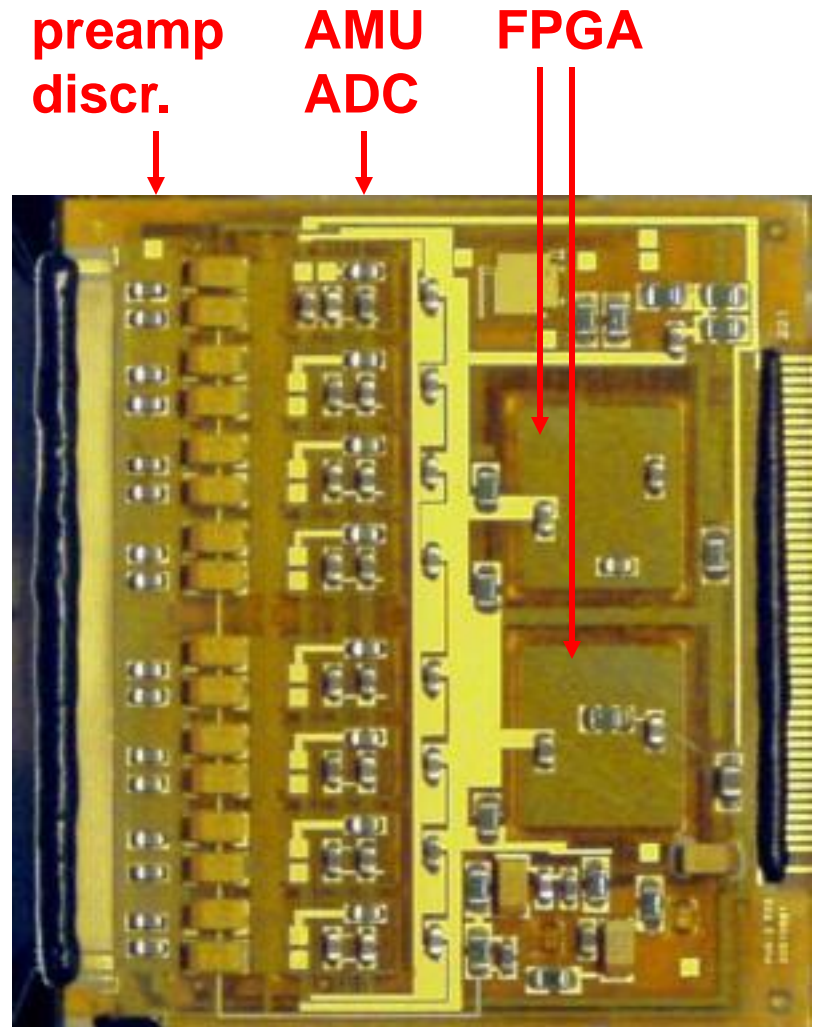
low yield

Final MCM yield was about 40%

This cabinet holds ~$0.5M worth of dead MCMs

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Purpose of the MVD

•Determine the event multiplicity. Because of the large eta-phi coverage, the MVD can provide an (more) unbiased total event multiplicity.

•(Locate the event vertex. Two layers of silicon is enough to find the vertex with precision of ~0.1mm)

•Determine the reaction plane.

•Look for fluctuations. Large eta-phi coverage helps the search for fluctuations.
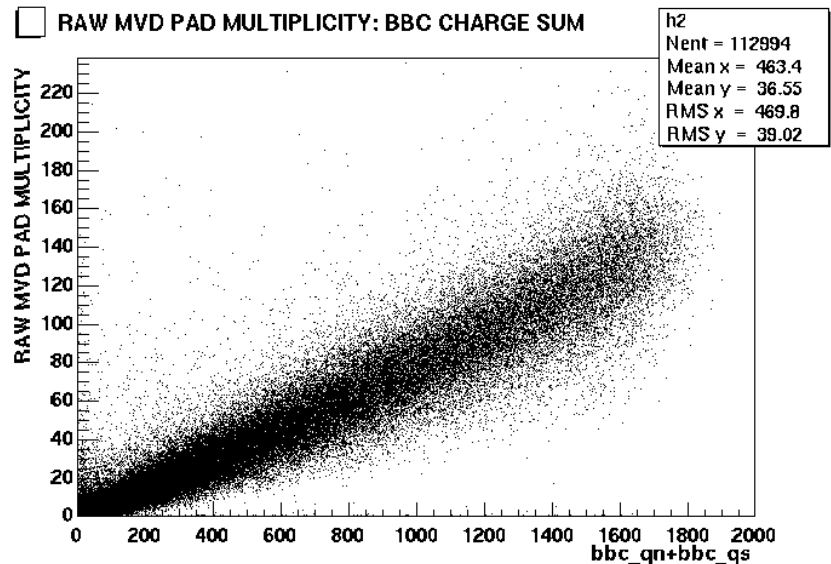
multiplicity

BBC charge sum
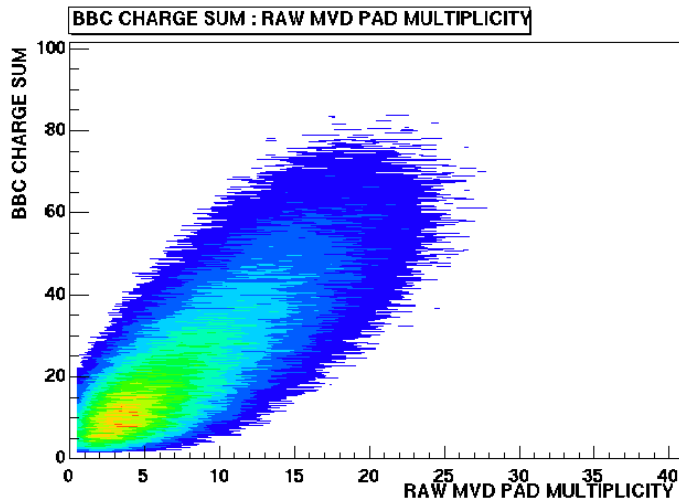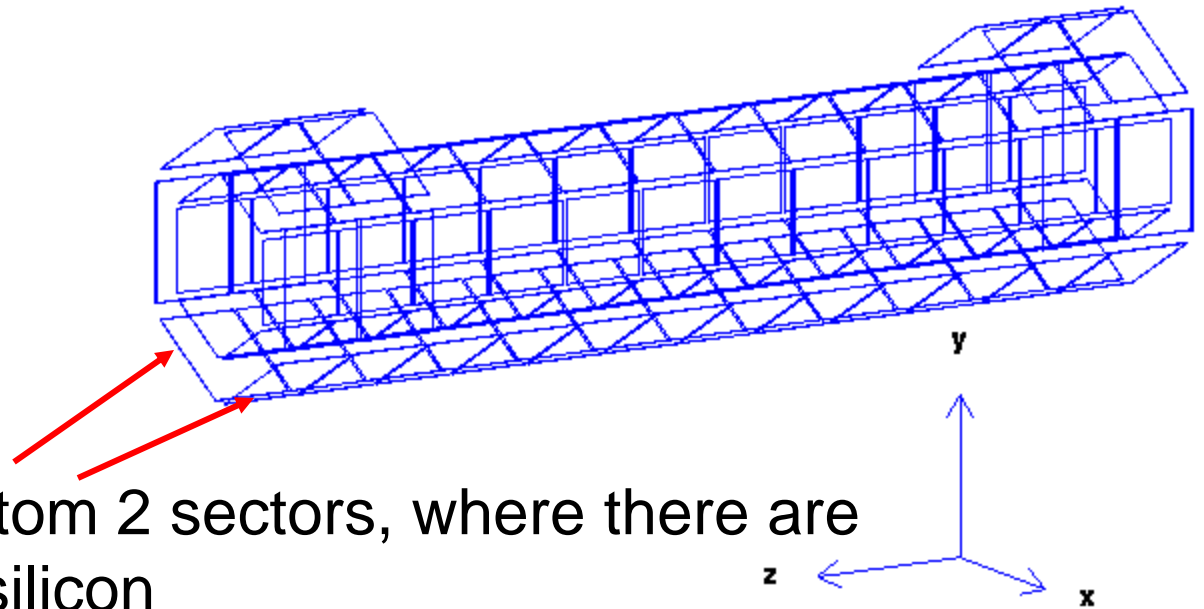

Run-3 d+Au

MVD pad hits

Year-2 Au+Au:
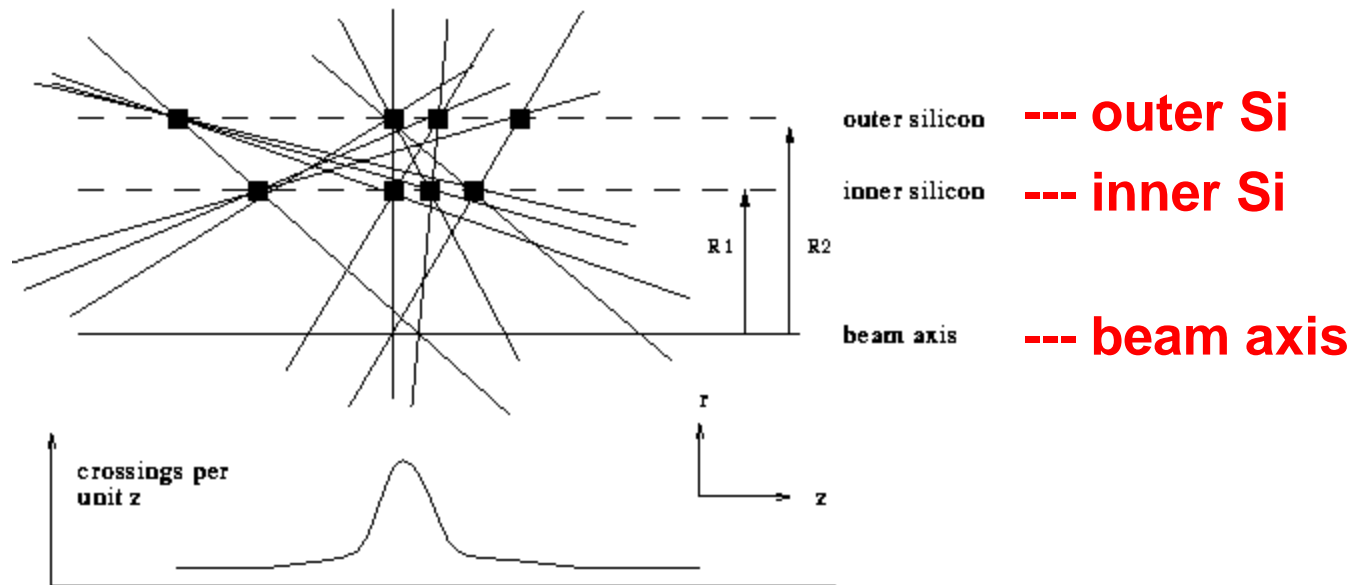
MVD pad mult

BBC charge sum

vertex finding

Use the bottom 2 sectors, where there are
2 layers of silicon

3 methods:
- pseudo-tracking
- correlation method
- cluster size

pseudo-tracking

--- **outer Si**

--- **inner Si**

--- **beam axis**

- Draw a line between every inner- and every outer-barrel cluster. Where most lines intersect the z-axis is the most likely vertex position.
- High resolution (in principle ~order 200um)
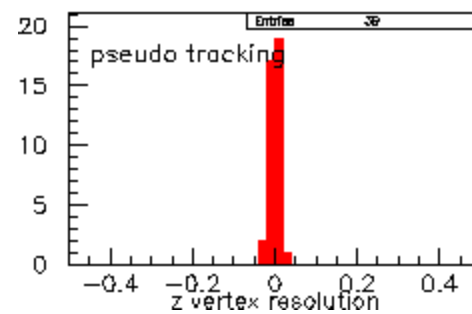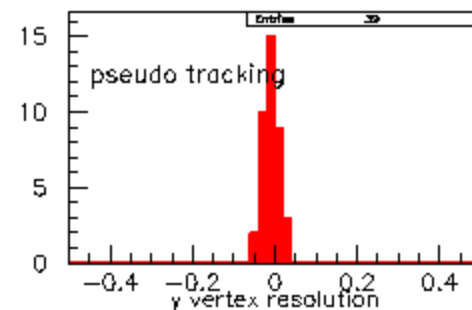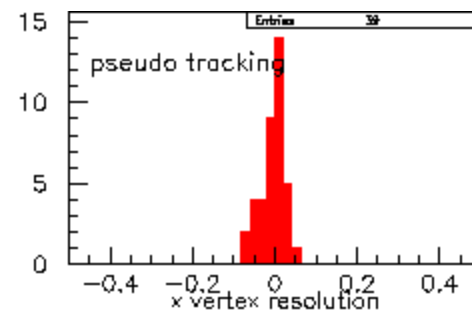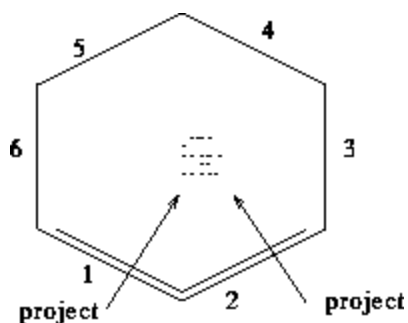- Needs matching inner-outer detectors
- Needs good knowledge of the geometry

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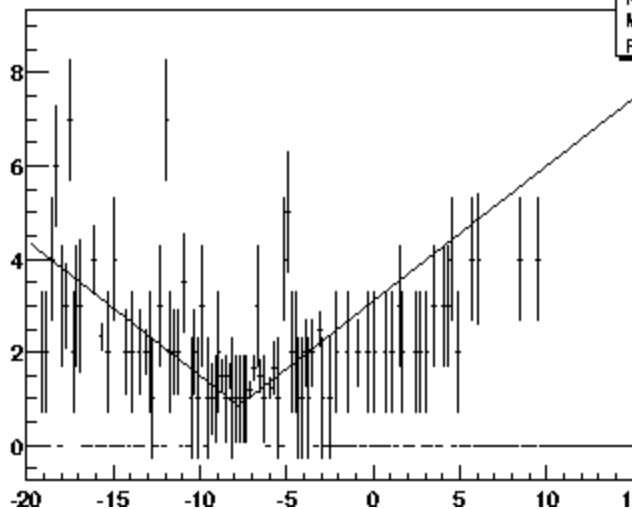
pseudo-tracking cont'd.

BBC vs.MVD
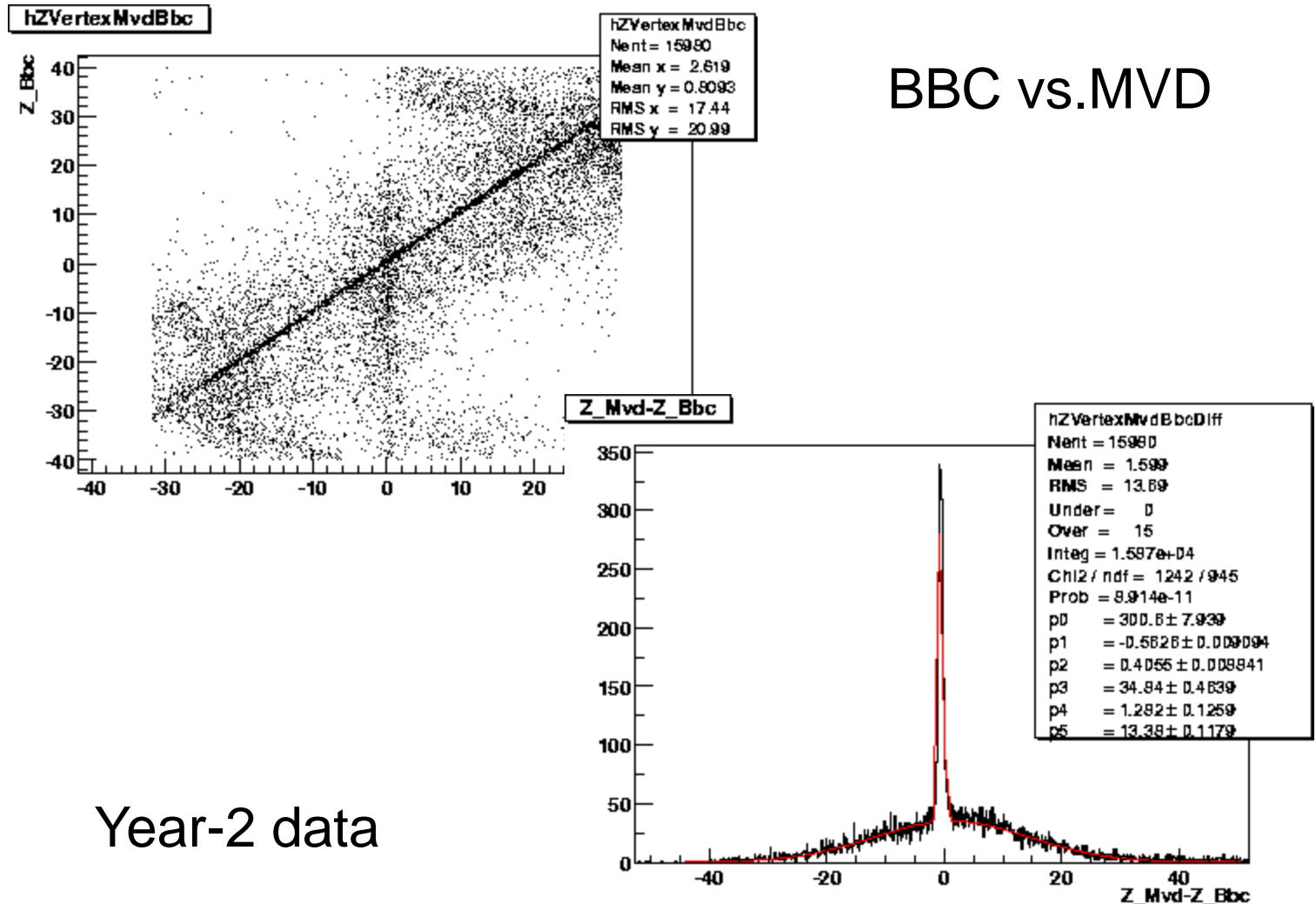
Year-2 data

pseudo-tracking, 3D

MC studies show that
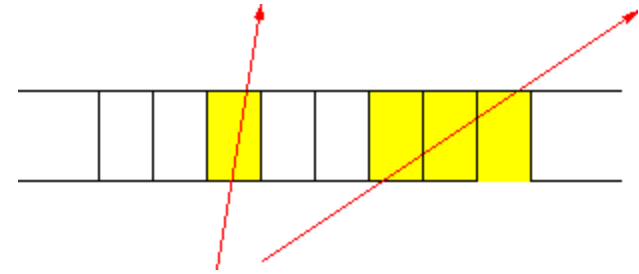the vertex can be
located in 3D using
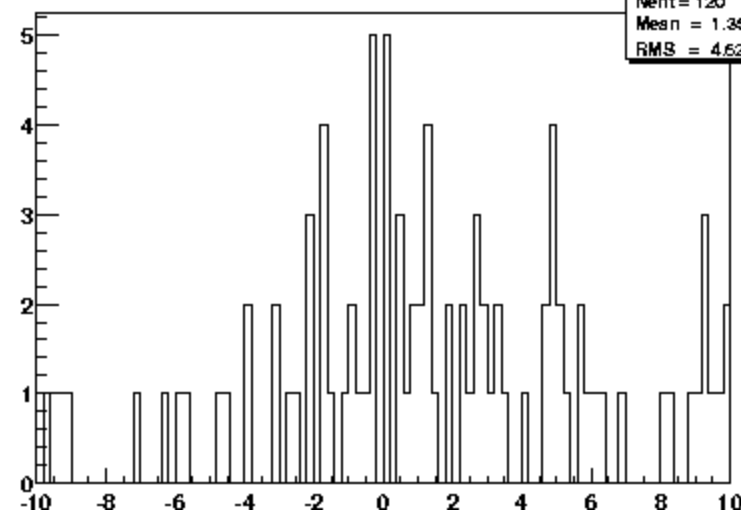the bottom 2 sectors

vertex finding by cluster size

Can use a single layer...
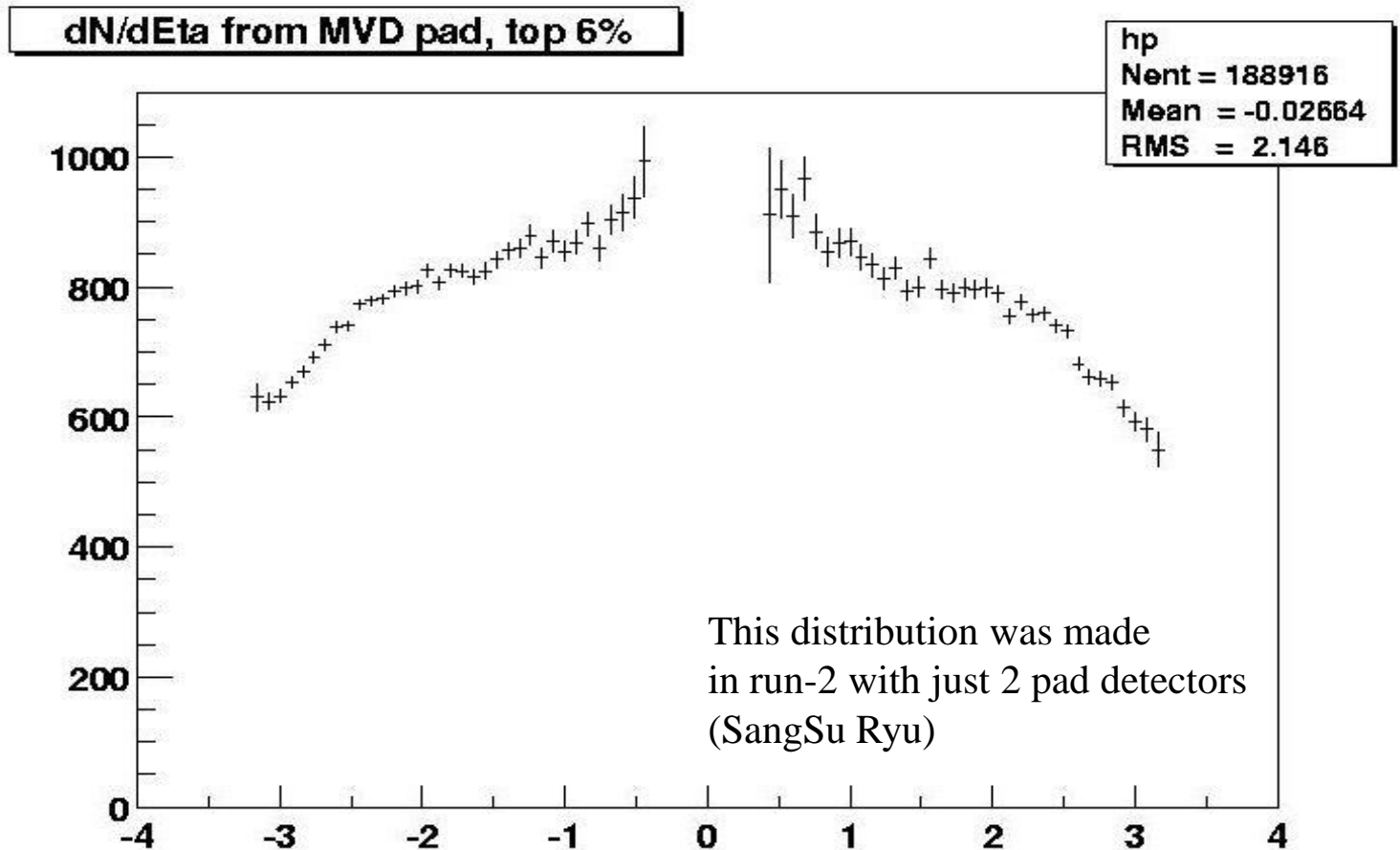
.. but resolution is low

correlation method

- The pattern of hits on the outer barrel is a stretched copy of the hit pattern on the inner barrel.
- Stretch the inner-barrel pattern to match outer-barrel scale
- slide patterns until they match

Not yet tried
on real data

MC

z vertex histogram

dN/dη
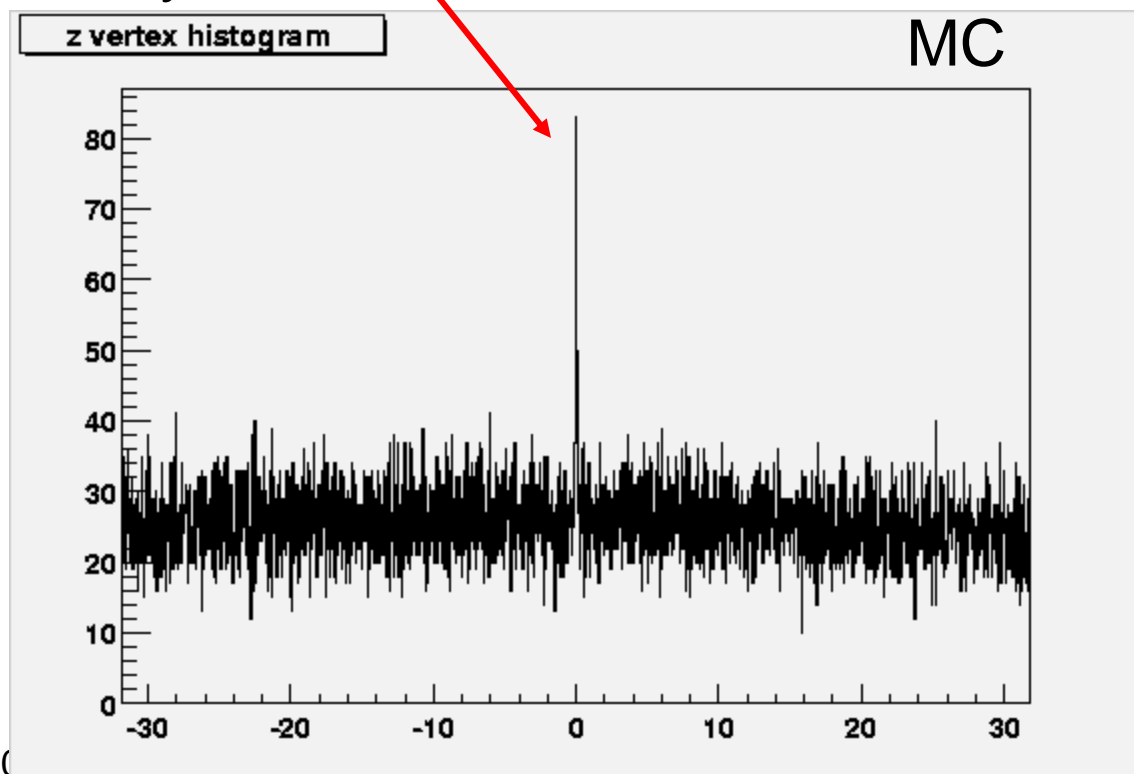
dn/dη can be determined from the strips or the pads:

dN/dEta from MVD pad, top 6%

hp
Nent = 188916
Mean = -0.02664
RMS = 2.146

This distribution was made
in run-2 with just 2 pad detectors
(SangSu Ryu)

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Note: this plot
may not be
shown publicly

d+Au: Hijing (1.37) Simulation

Output =
Pad detector
"signal" +
background

dN$_{ch}$/dη

Simulation
input

Input/Reconstructed

~0.8

dN/dη

η

output/input

η
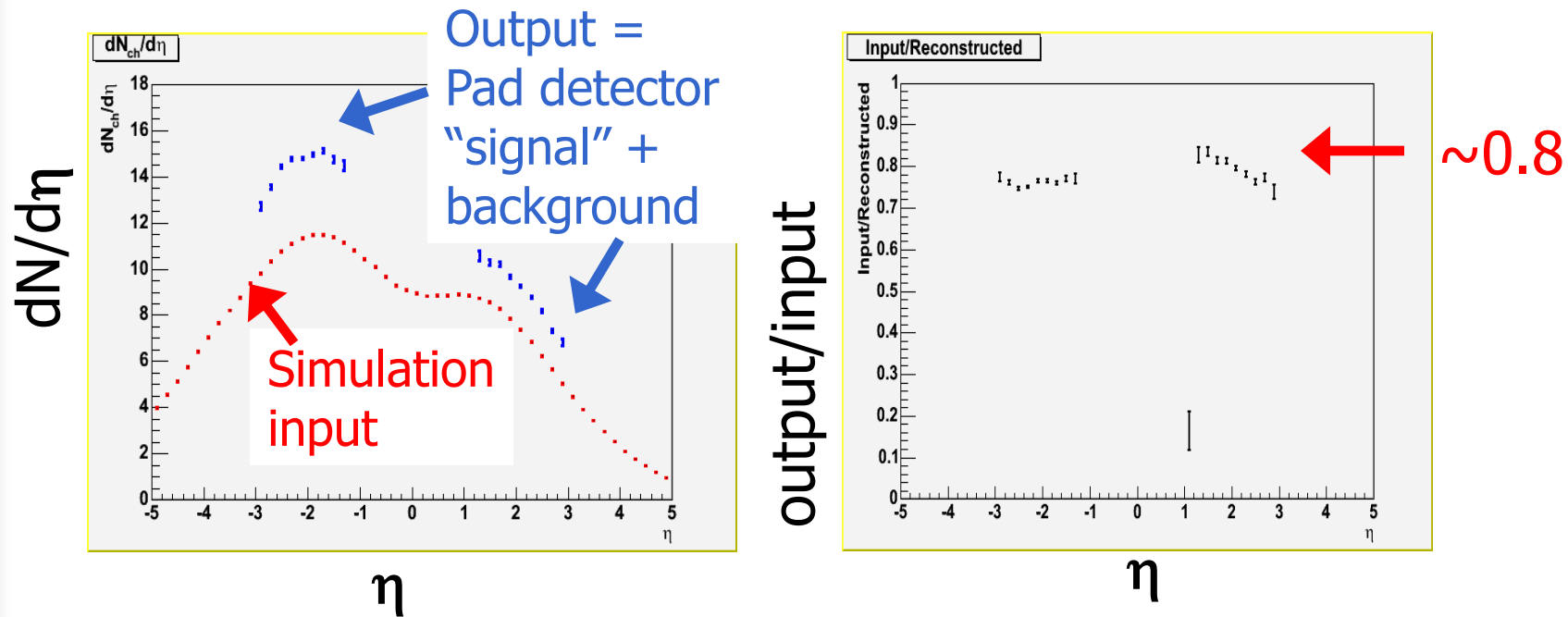
- Full simulation of Hijing event generator including detector and reconstruction
- Background particles includes all particles which are not primary and loopers
- The ratio of reconstructed to input accounts for both background and reconstruction efficiency
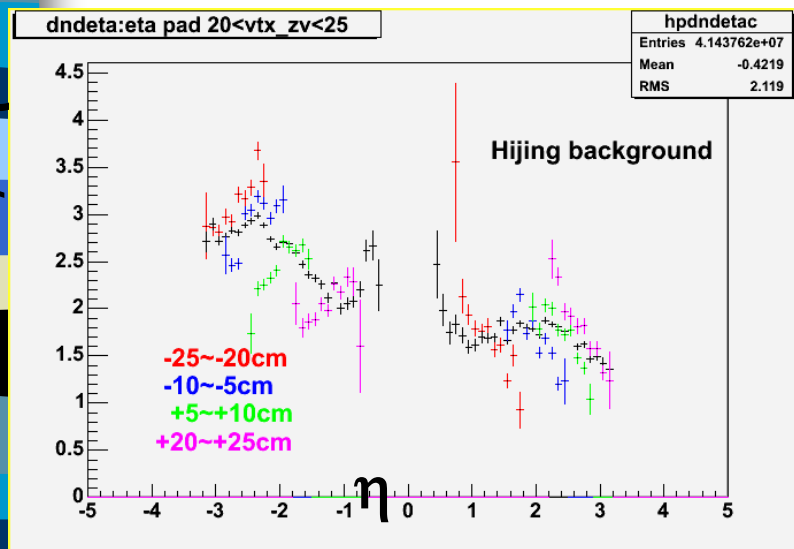
Initially: dN/dη depended on Z$_{vtx}$

dndeta:eta pad -25<vtx_zv<-20

hpdndetab m25m20
Nent = 2548600
Mean = 1.115
RMS = 1.953

-25~-20
-10~-5
+5~+10
+20~+25

Au+Au data (not normalized), dN/dη in pad detectors for different Zvtx bins
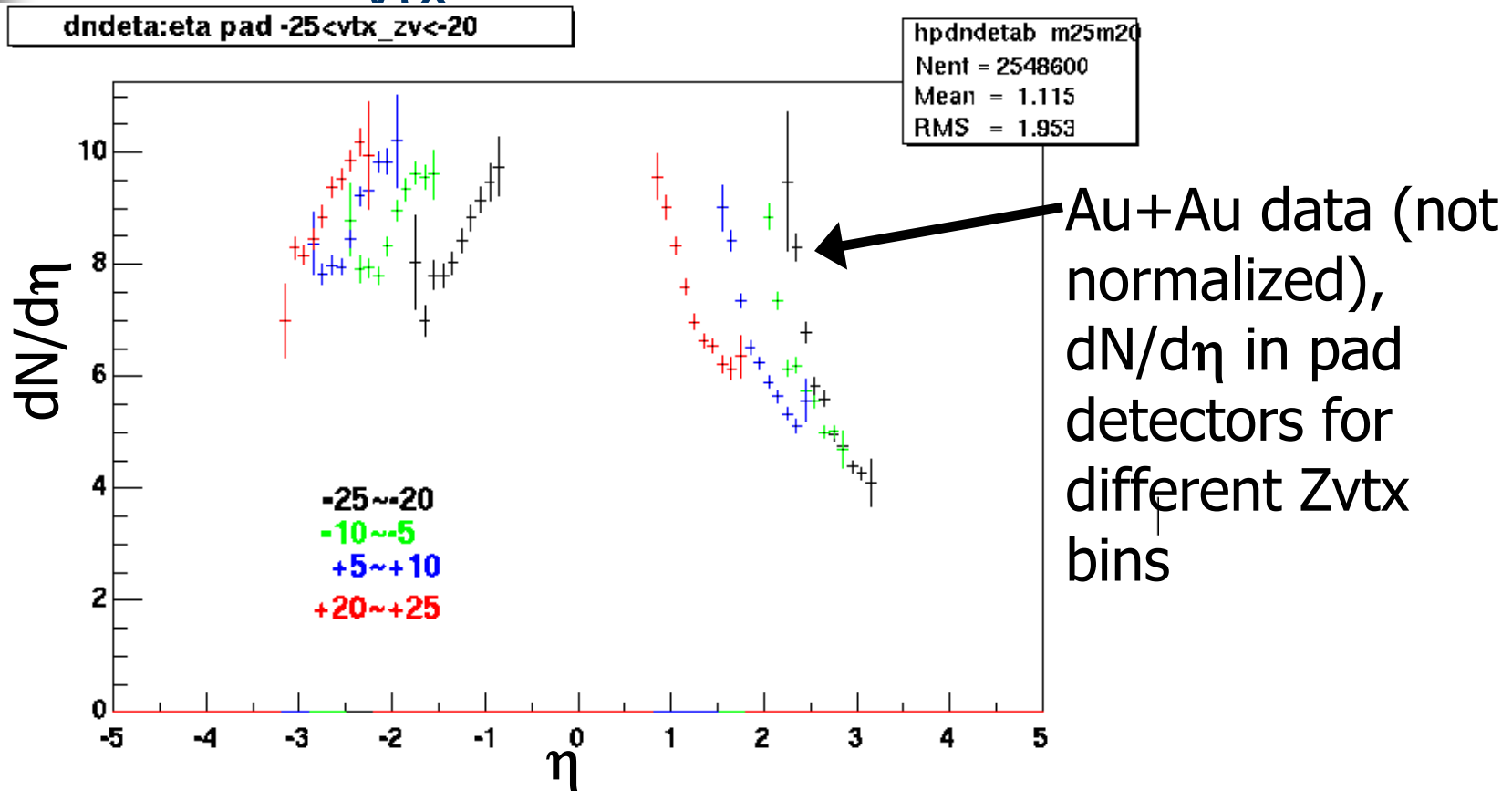
What is the cause of this vertex dependence?

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Simulations: dN/dη from background

dN/dη from background:

dN/dη from primary particles:
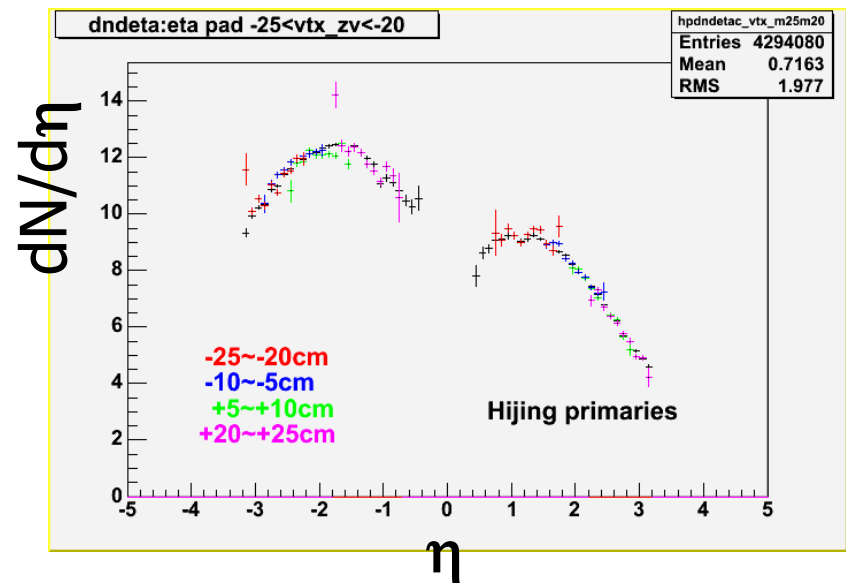
Depends on Z_{vtx}

Does not depend on Zvtx

Why does dN/dη from background depend on Zvtx?

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Background vs. R

The pads get larger at larger R. This keeps the $\Delta\eta$ ~constant with R.

However, the background does not depend strongly on R – so the bigger pads at larger R have proportionately more background.

This is the main cause of the Zvtx dependence of the background.

A smaller, but significant effect is the larger capacitance (and hence slightly larger noise) in larger pads.
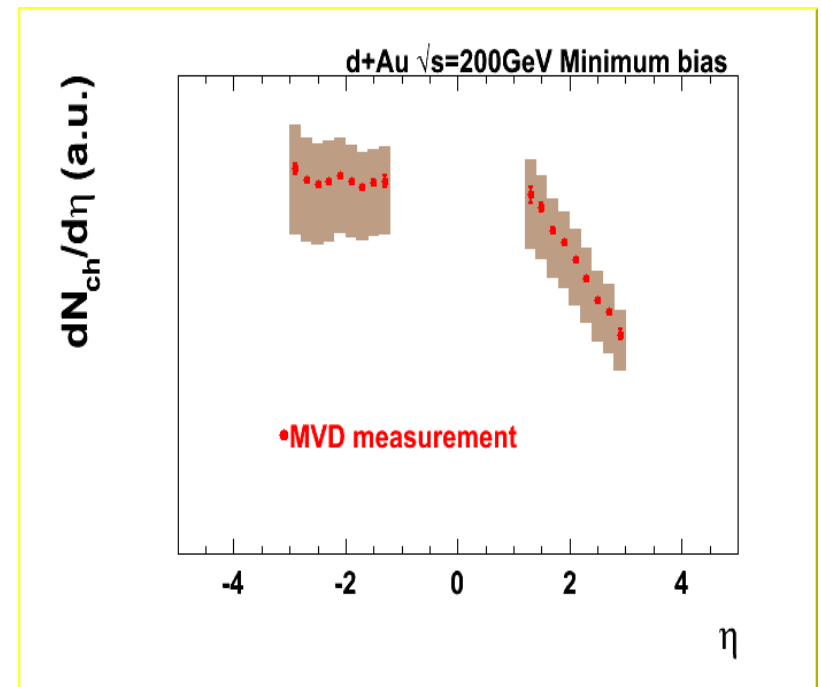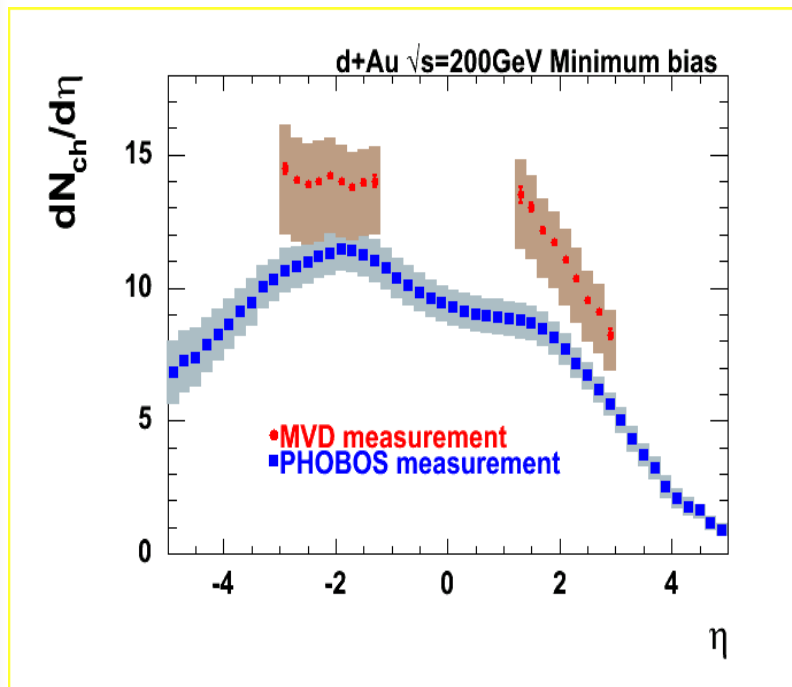

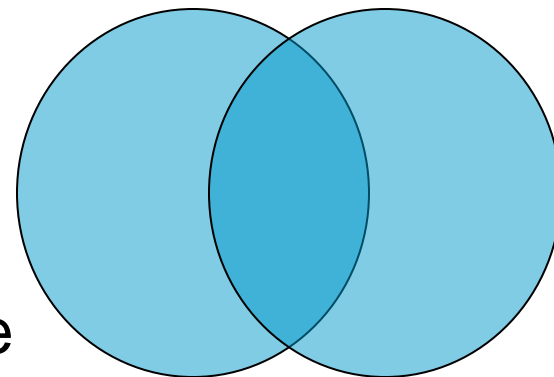Phenix Focus March 2004
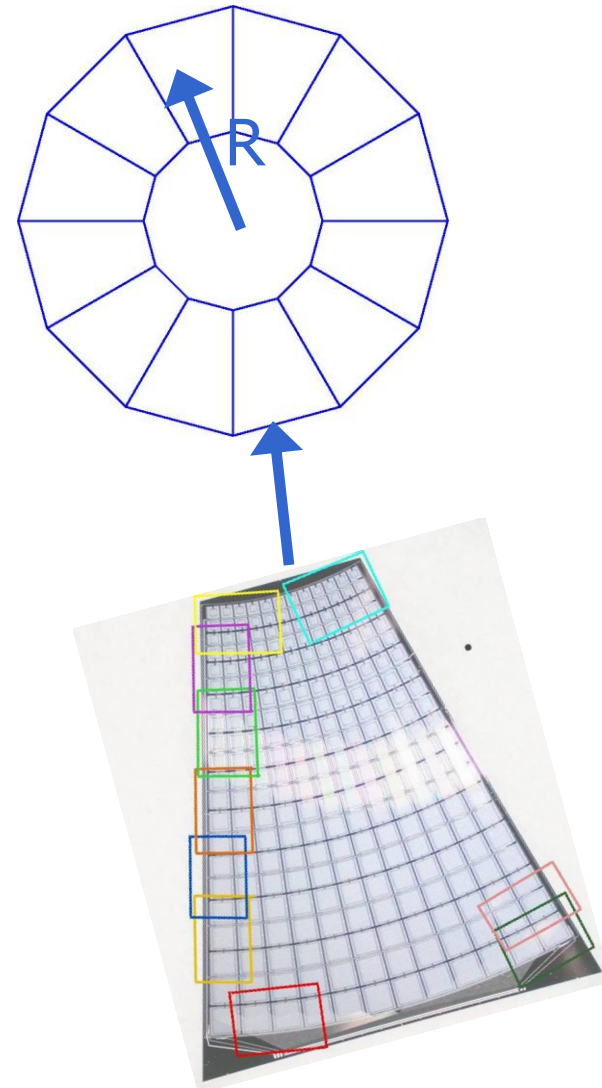
d+Au: dNch/dη for Minimum Bias events
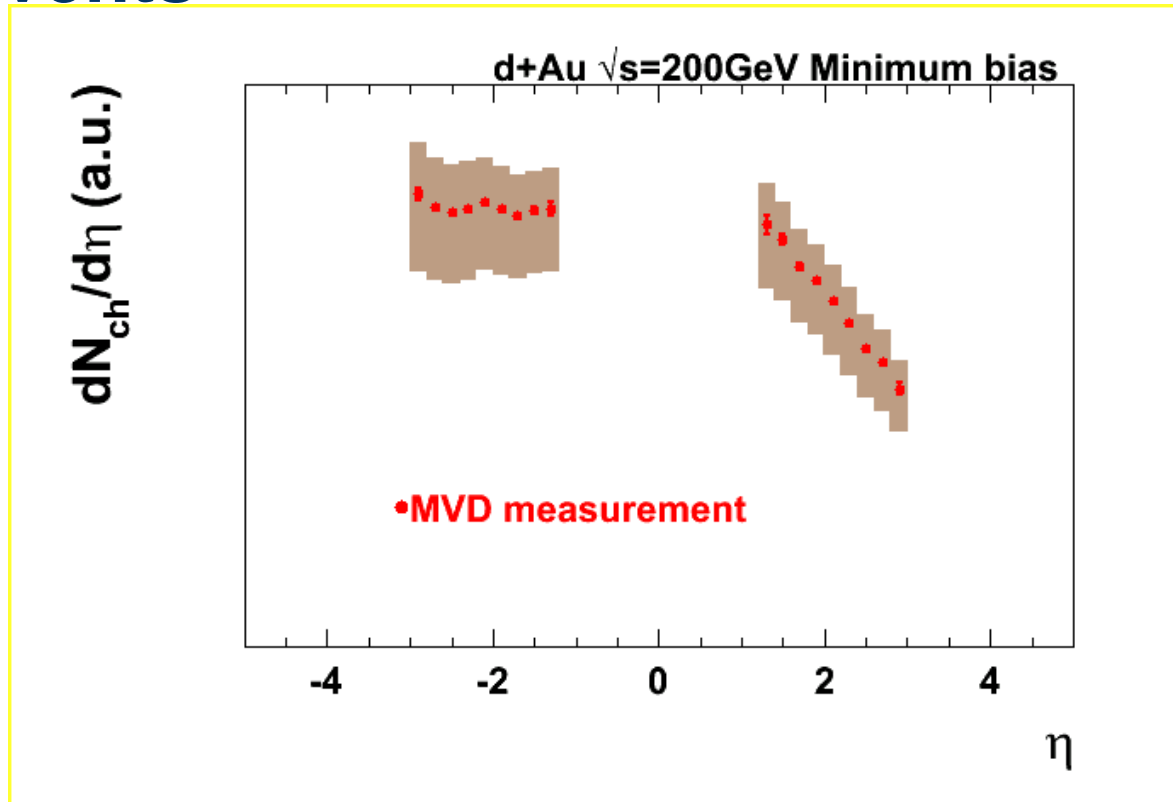
Sangsu Ryu

- dN$_{ch}$/dη has reasonable shape
  - Shaded bars represent uncertainty in the estimation of background

- Needs more background study and normalization

This slide is not for the DOE

d+Au √s=200GeV Minimum bias

- MVD measurement
- PHOBOS measurement

d+Au √s=200GeV Minimum bias

- MVD measurement

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Reaction plane

Even with only the pad detectors, the MVD should be able to make good measurements of the reaction plane in AA collisions.

Pad detectors ~25% more particles than BBC in ~47 times as many channels. (Whole MVD is x5 more particles).

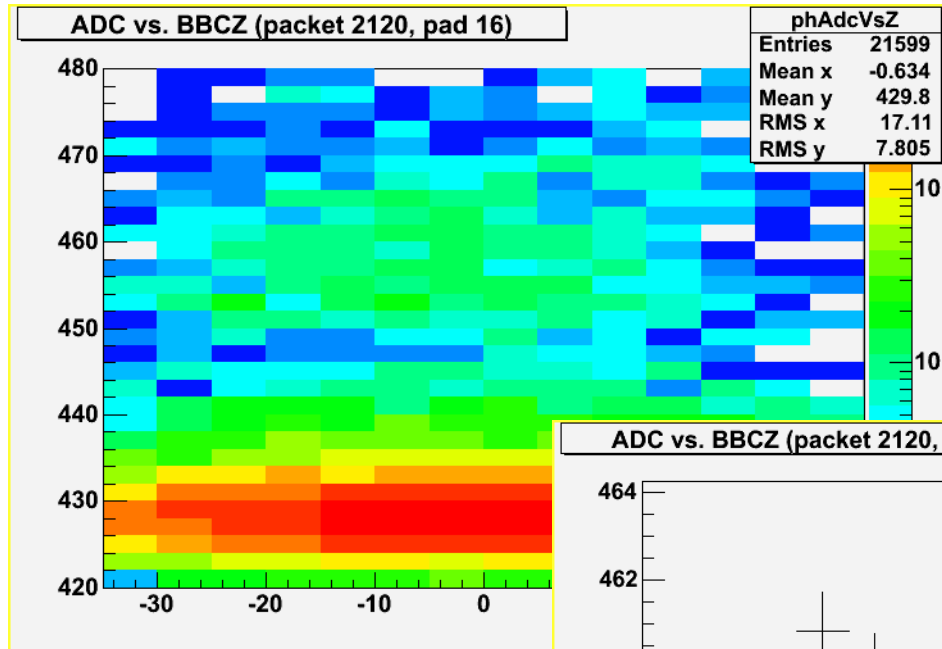MVD and BBC acceptance do not generally overlap – so these augment current BBC capabilities.

This gives another interesting way to look at jet suppression and J/Ψ suppression vs. the length of excited matter traversed.

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Event plane analysis

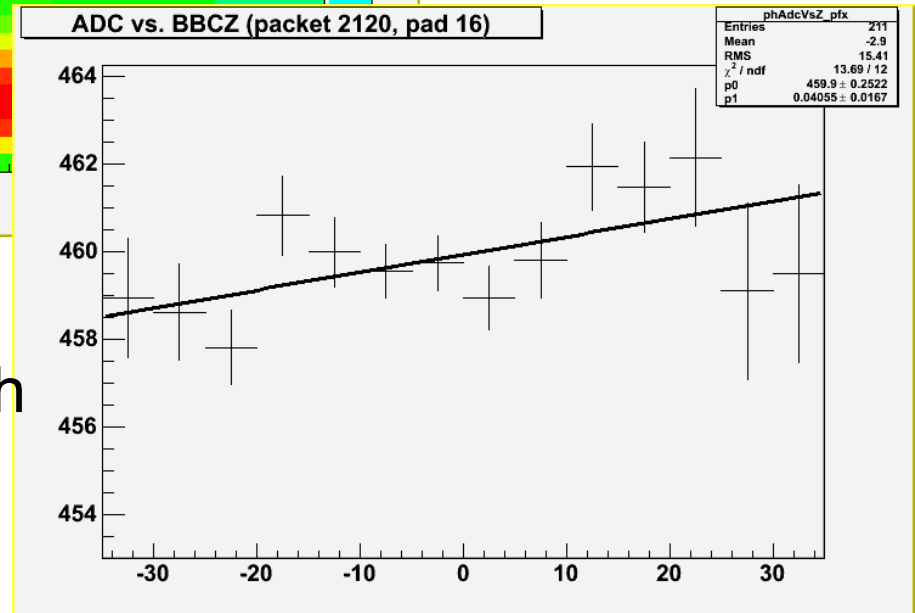- Just starting… (Ben Norman)

Phenix Focus March 2004
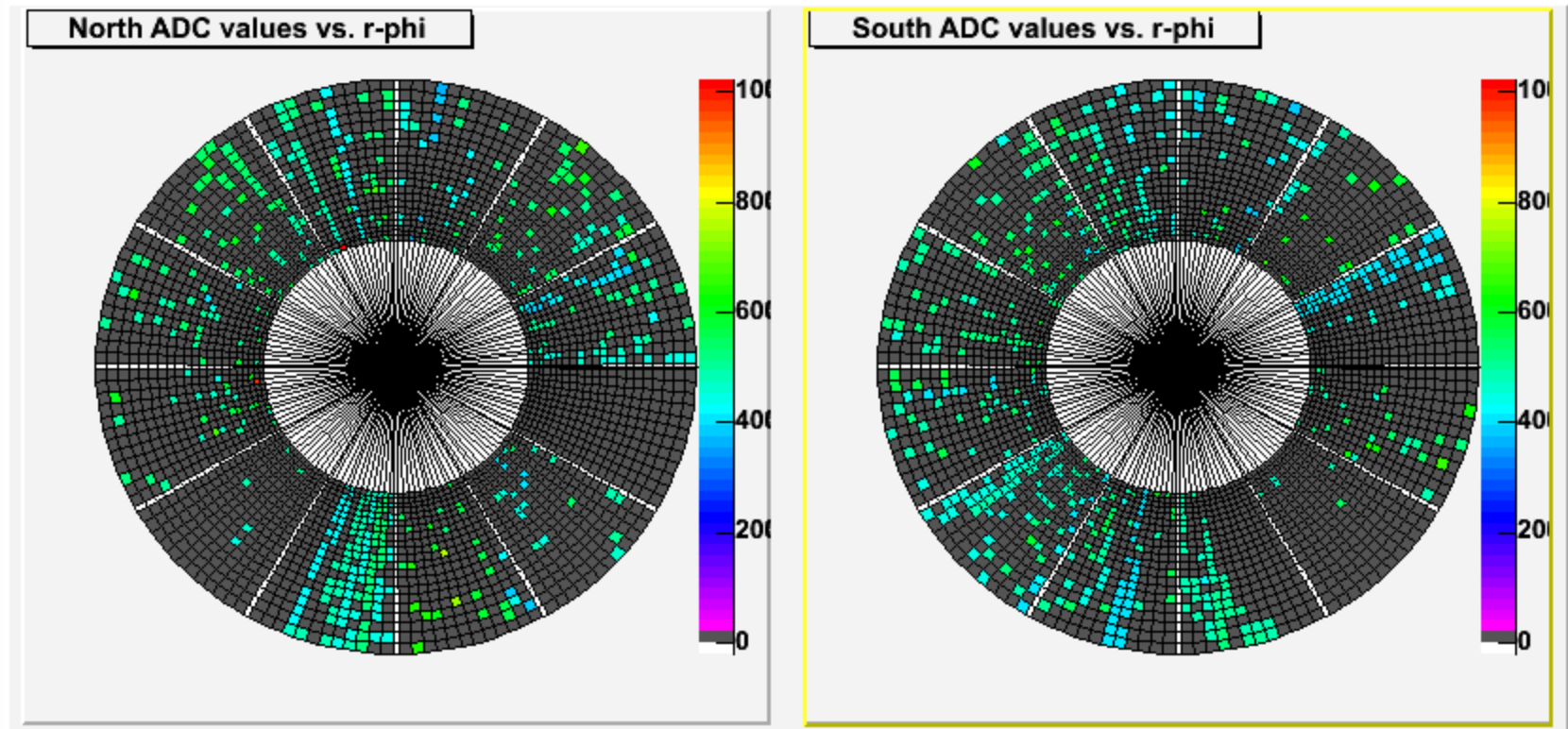
Use ADC values or not?

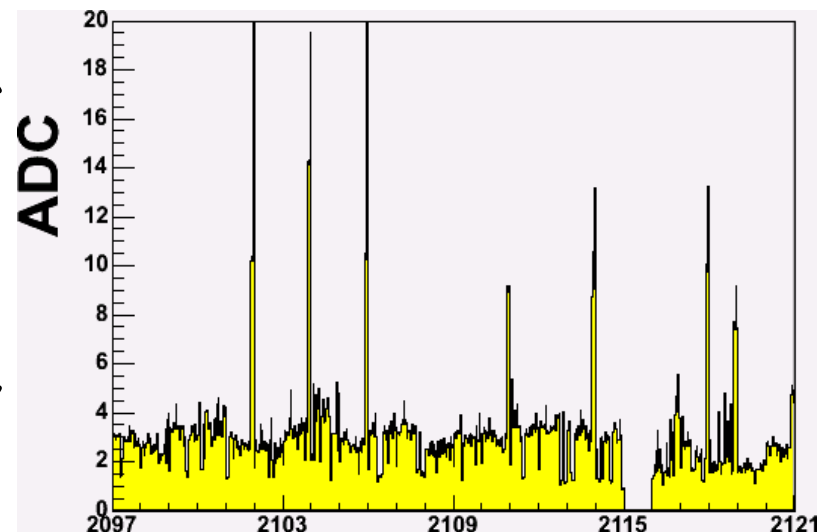Hits per pad ~1

ADC follows path length

Current online plots

mean

Mean signal (ADC chan)

~45

Pedestal σ (ADC chan)
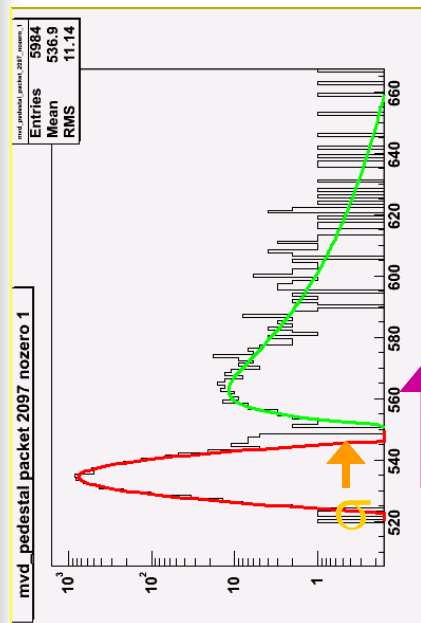
Channel

Typical signal/noise = 15/1 (good)
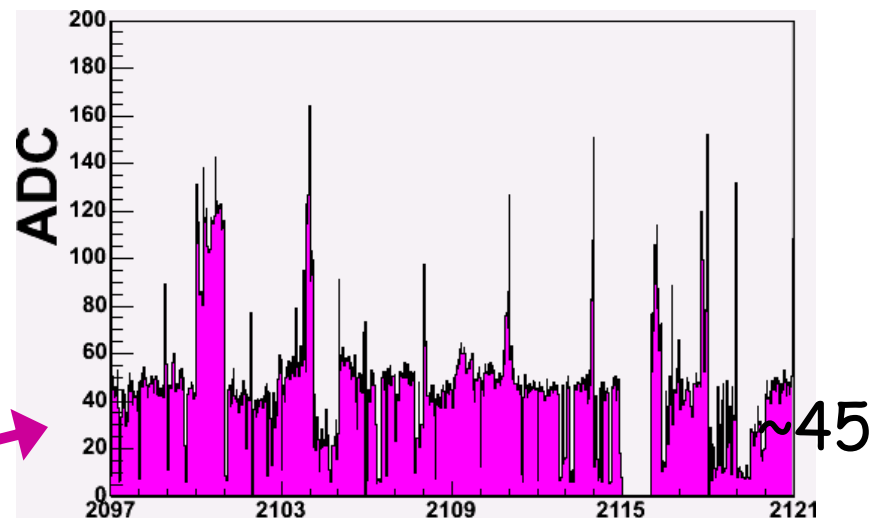
Run4 – online monitoring plots
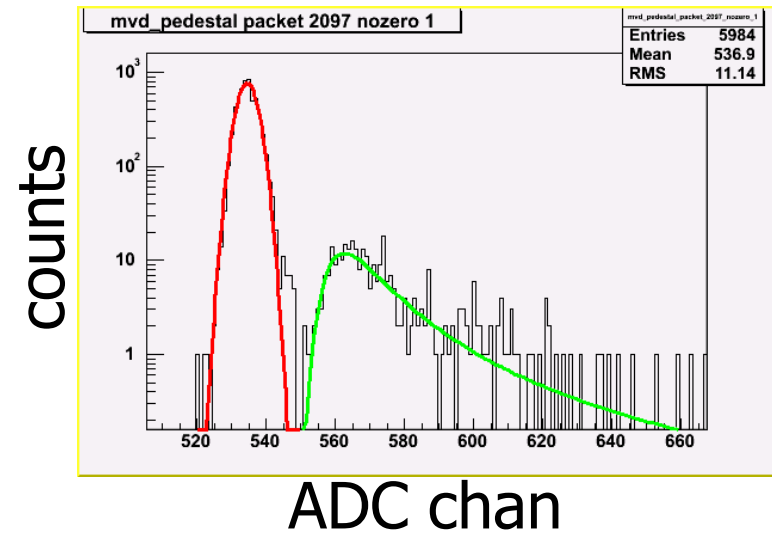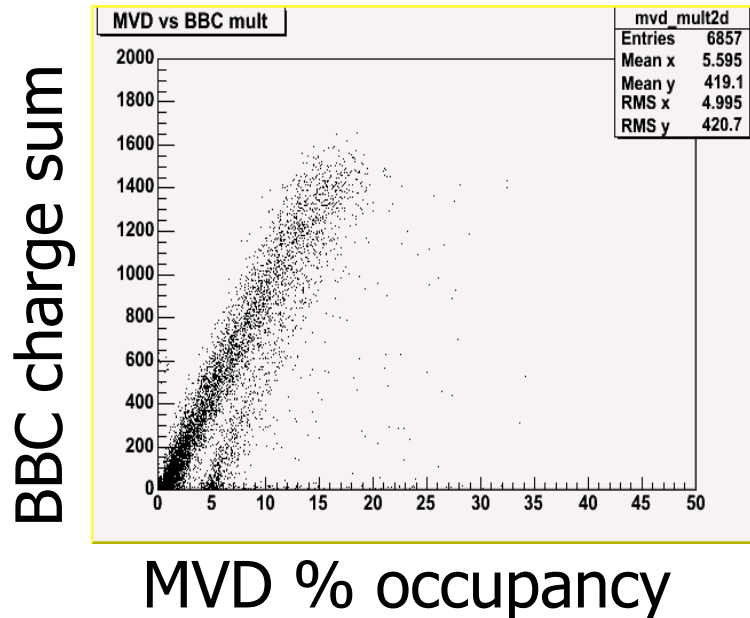
The detector is working well
in run 4.

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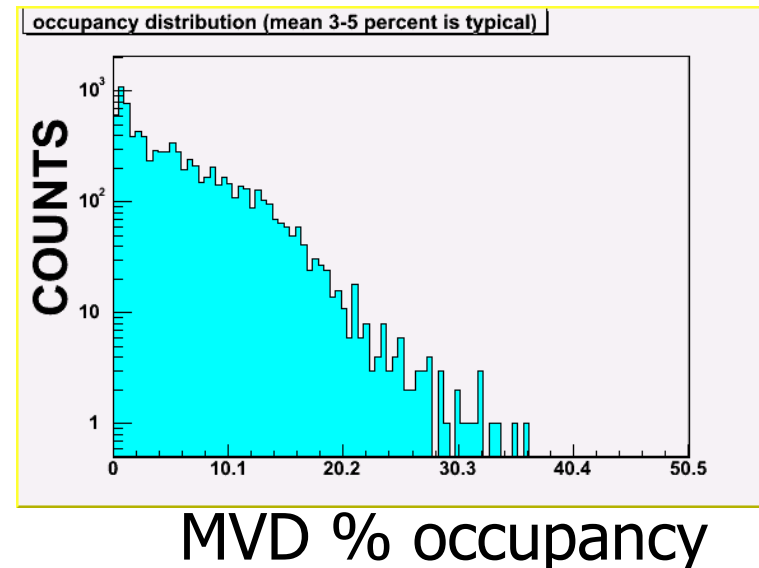
people past and present

Los Alamos: Barbara Jacak, <u>John Sullivan</u>, <u>Hubert van Hecke</u>, Jan Boissevain, Walt Sondheim, Debbie Clark, Michael Bennett, Jon Kapustinsky, SangKoo Hahn, Allan Hansen, Gary Smith, Bernd Schlei, Larry Marek, Nu Xu, Rachel Cunningham, Richard Conway. Recently: <u>Ben Norman</u>

U. of Alabama: Toshi Shiina, Y. Takahashi

Yonsei University: Ju Kang, <u>SangSu Ryu</u>, <u>IhnJea Choi</u>, YoungGook Kim,SangYeol Kim, Jeong-Hwan Park
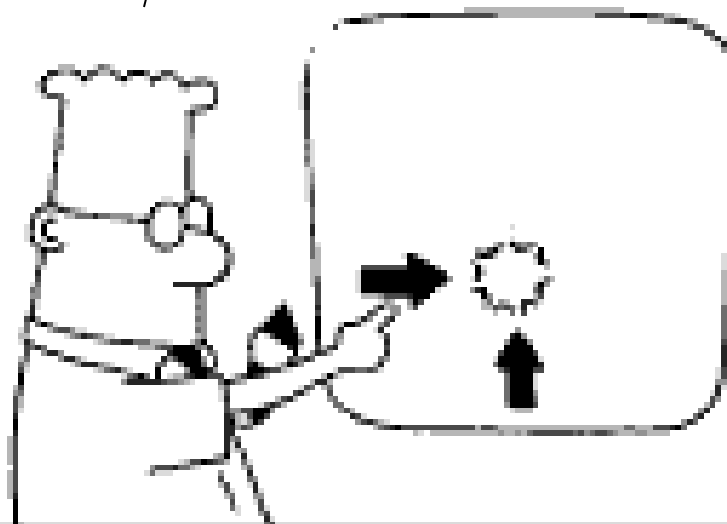
Oak Ridge: Chuck Britton, Nance Ericson, Mike Emery, Ryan Lind, Tony Moore, Mike Simpson, Alan Wintenberg, Melissa Smith, Milko Bobrek, Mark Allen

U.C.Riverside: David Jaffe, James Chang, Eric Bosze, Tahsina Ferdousi, Sun-Yiu Fung, Richard Seto, Guanghua Xu

Mostly past, so...

future

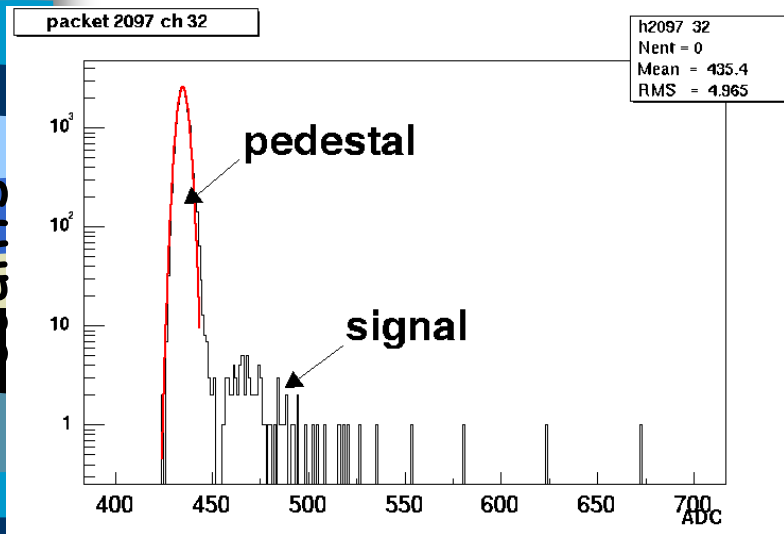# backups

- .

MVD – run 3 d+Au

1st Calibration step: fit pedestal

2nd calibration step: more counts, pedestal subtracted, fit Landau

packet 2097 ch 32

h2097_32	
Nent = 0	
Mean = 435.4	
RMS = 4.965	

pedestal

signal

ADC chan

packet 2097 ch 100

Landau fit

Pedestal cut off

ADC-pedestal

counts
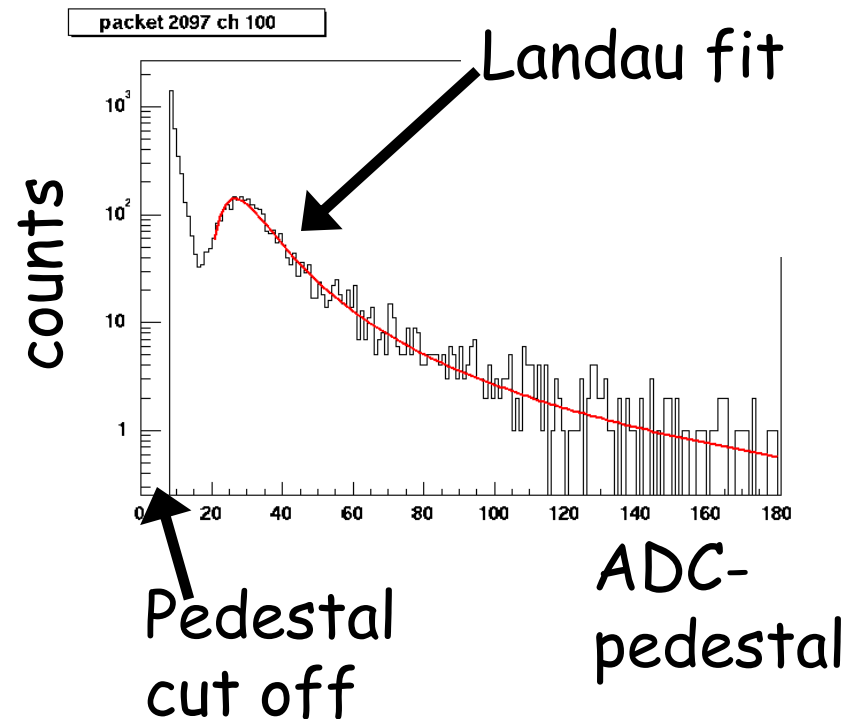
Noise levels acceptable in pad detectors. Notice that it is a hard problem – occupancy is only a few parts in 1000.

MVD Key Parameters

■ **Active region and acceptance**

Inner barrel: |z|<32cm, r=5cm ($|\eta|$<2.5)

Outer barrel: |z|<32cm, r=7.5cm

Pads: r=5~12cm at z=+-35cm (1.5<$|\eta|$<3)

Inner barrel and pads have full azimuthal coverage

Outer barrel covers only bottom 1/3 of azimuthal angle

■ **Channels**

Inner barrel: 12 ladders X 6 wafers X 256 channels
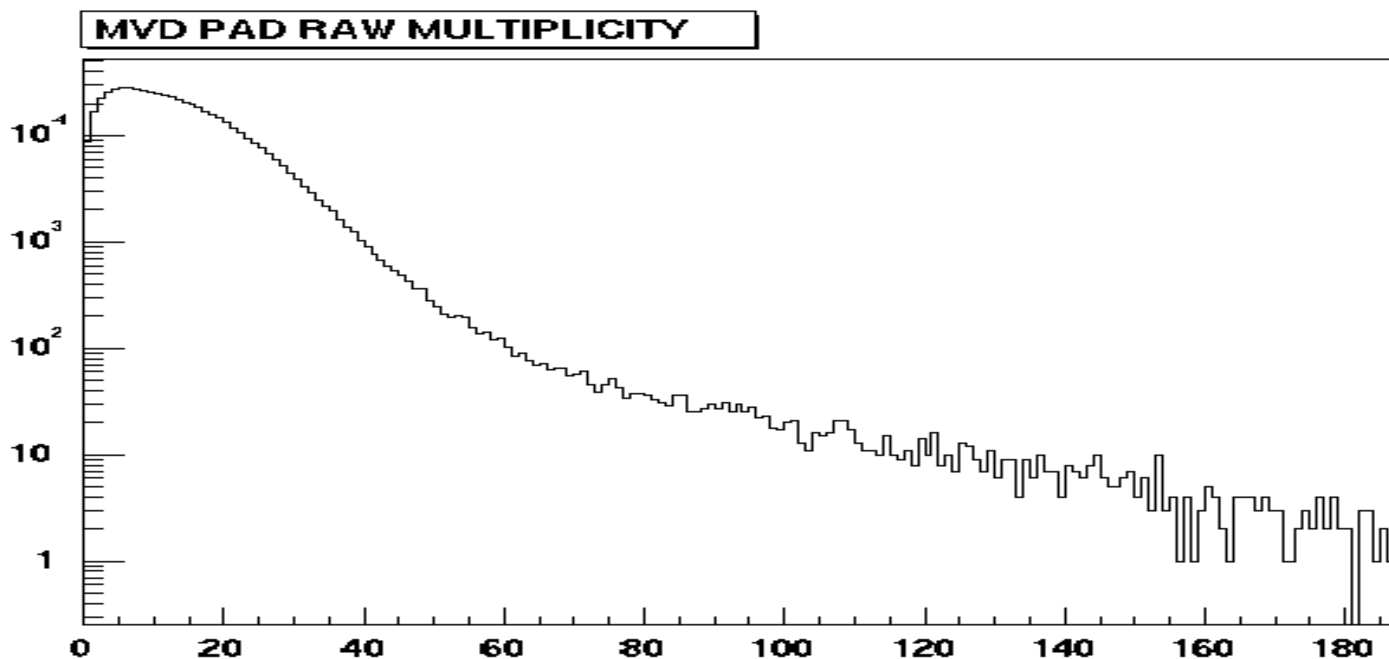
Outer barrel: 4 ladders X 6 wafers X 256 channels

Pads: 2 (south, north) X 12 wedgesX 252 channels

Total: 30.6K channels

• **Thickness**

Radiation length=0.61% for tracks traversing 1 silicon detector

Raw MVD Pad Multiplicity

MVD PAD RAW MULTIPLICITY

- Number of on–channels (4σ pedestal cut) in all   working MVD pad detectors is shown

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dN/dη

Run-1 (130GeV),
2 strip detectors,
2 runs

Tahsina Ferdousi
Richard Seto

all chips dN/dEta

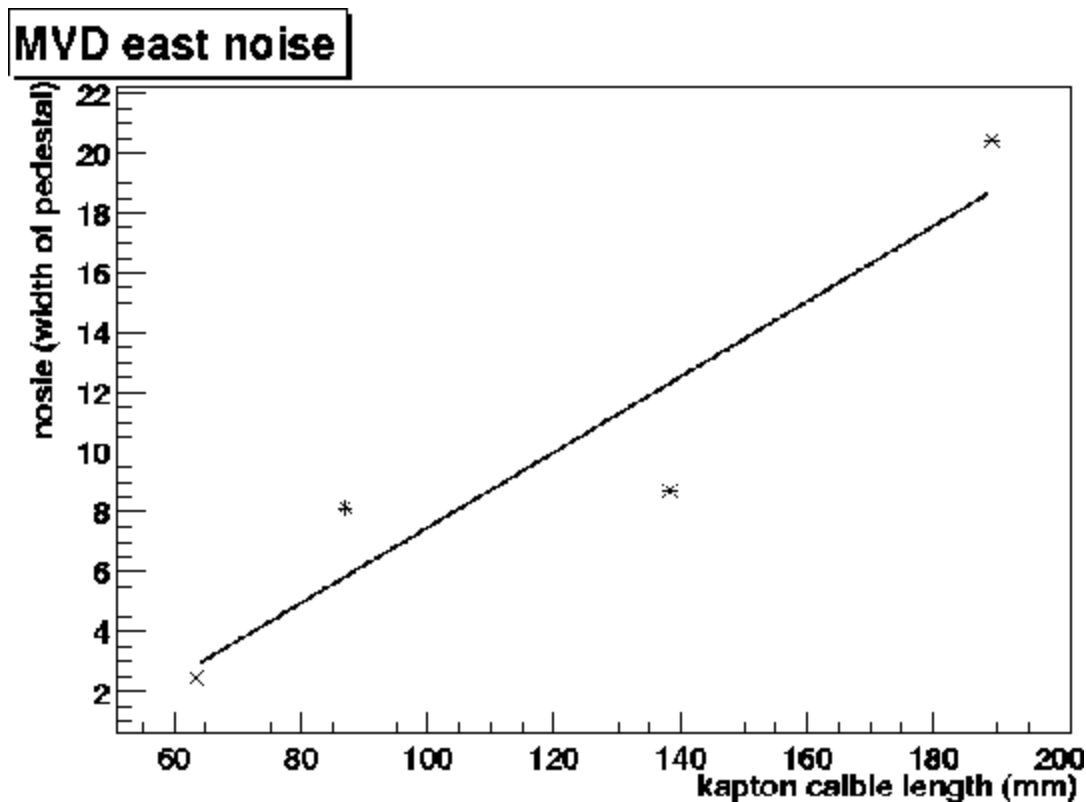| min-bias |
| top 5% central events |
| 5%-10% central events |
| 10%-15% central events |
| 15%-20% central events |
| 20%-25% central events |
| 25%-30% central events |
| 30%-35% central events |
| 35%-40% central events |

all chips dN/dEta vs Eta
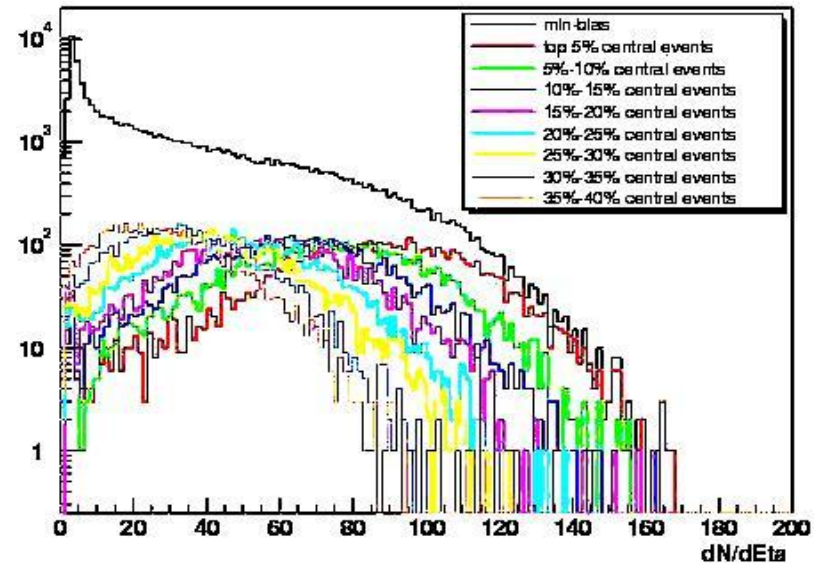
<dN/dη> for min bias
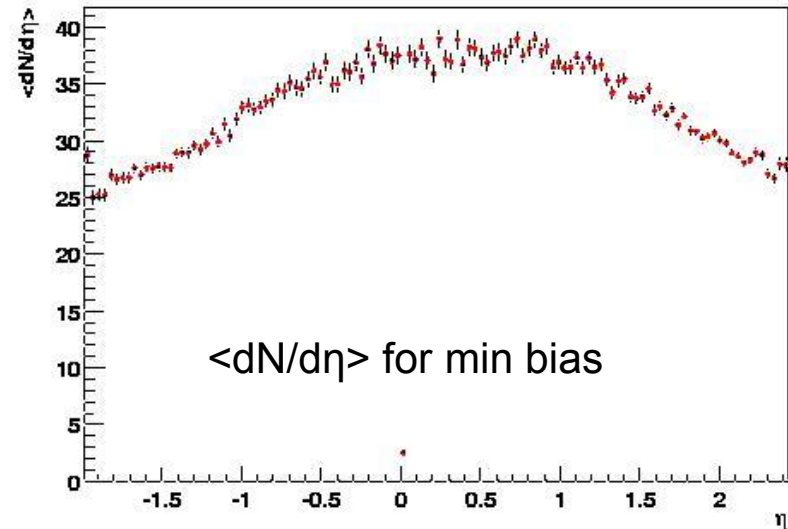
... and the bad news

Last year, we saw pedestal width ~ proportional to the kapton cable length (=0 for pads).

MVD east noise

And the kapton cables are not well shielded (low mass)

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